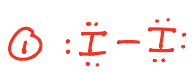
Lesson 10 – Polar and Ionic Compounds Worksheet

Note: *London dispersion forces are often abbreviated as LDF*

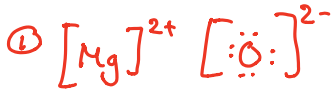
1. Draw the Lewis structure or Lewis diagram of the molecules presented below and identify the major attractive intermolecular forces.

a) I_2



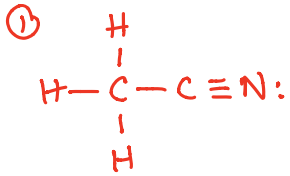
② London dispersion forces (often abbreviated as LDF)

b) MgO



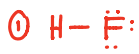
② Ion - ion

c) CH_3CN



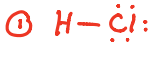
② dipole - dipole

d) HF



② hydrogen bonding

e) HCl



② dipole - dipole

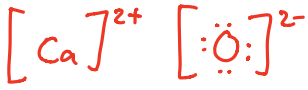
2. Draw the Lewis diagram of the following ionic compounds.

a) NaF

c) K_2O

or

d) CaO



Questions, other than #2, are from http://butane.chem.uiuc.edu/anicely/chem102dfa10/Worksheets/Worksheet15_IMF.pdf

For the next three questions: (1) Identify the type of compound,
(2) Identify the major intermolecular forces
(3) Use (1) and (2) to answer the question

3. Which of the following substances is most likely to exist as a crystalline solid at room temperature. Which of the substances is the most likely to exist as a gas at room temperature?

a) HF
(1) polar
(2) dipole-dipole

b) PCl_3
(1) polar
(2) dipole-dipole

c) $FeCl_2$
(1) ionic compound
(2) ion-ion

d) SO_2
(1) polar
(2) dipole-dipole

e) F_2
(1) non-polar
(2) LDF

- $FeCl_2$ is expected to have the highest melting point due to the ion-ion interaction, so it is the most likely to be a solid at room temperature.
- F_2 is expected to have the lowest boiling point given that its LDF are weak (small + not a lot of electrons). Therefore, it is the most likely to be a gas at room temperature

4. Which of the following is expected to have the highest boiling point? Which one is expected to have the lowest boiling point?

a) CO_2
(1) non-polar
(2) LDF

b) Ar
(1) non-polar
(2) LDF

c) CF_4
(1) non-polar
(2) LDF

d) LiCl
(1) ionic compound
(2) ion-ion

e) SiF_4
(1) non-polar
(2) LDF

- LiCl has ion-ion interactions and is therefore expected to have the highest boiling point.
- Since the other compounds are restricted to LDF, we can rank them based on their *number of electrons* since it will affect the magnitude of the LDF. CO_2 has 22 electrons, Ar has 18 electrons, CF_4 has 42 electrons, and SiF_4 has 50 electrons. Given that Ar has less electrons it exhibits weaker LDF forces, which means that it is expected to have the lowest boiling point.

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5. Give an explanation in terms of intramolecular/intermolecular forces for the following differences in boiling point.

a) HF (20° C) and HCl (-85° C)

HF: polar; has hydrogen bonding

HCl: polar, has dipole-dipole interactions

- Since hydrogen bonding is a stronger force compared to regular dipole-dipole interactions, HF has a higher boiling point.

b) $CHCl_3$ (61° C) and $CHBr_3$ (150° C)

$CHCl_3$: polar; dipole-dipole interactions

$CHBr_3$: polar; dipole-dipole interactions

- We would expect $CHCl_3$ to have slightly stronger dipole-dipole interactions given that Cl is more electronegative compared to Br. However, it is $CHBr_3$ that has the highest boiling point of the two. There is clearly another force at work here: London dispersion forces. If we count the number of electrons in each compound, we see that $CHBr_3$ has more electrons than $CHCl_3$ and therefore stronger LDF forces. Consequently, CHBr3 has the higher boiling point.

c) Br_2 (59° C) and ICl (97°C)

Br_2: non-polar; London dispersion forces

ICl: polar; dipole-dipole interactions

Note that Br_2 and ICl have the same number of electrons and therefore we expect the LDF to be similar between both compounds. Since ICl can participate in dipole-dipole interactions, which are stronger than the LDF of Br_2, it will have the highest boiling point.

Here, ICl will have the higher boiling point. Note the different

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